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VOLUME III NUMBER 7

THE ELEMENTARY SCHOOL TEACHER

MARCH, 1903

BOTANY IN ELEMENTARY SCHOOLS.

THE use of plants in elementary instruction has become so well established as to need no defense. The problem is not whether plants shall be studied, but what is the most effective method of using them. There are certain general principles that seem to be clear, and may be stated; but their application demands a certain amount of experience on the part of the teacher and great amount of detail. The principles that should control any handling of plants in elementary instruction may be stated as follows:

1. There should be no organization of a science of botany, with a logical beginning and development. Such presentation of a science belongs to more advanced instruction. This means that no logical order is to be followed, so far as the subject of botany is concerned, but that selection is to be made from the wealth of material present in every region. It is not continuity of subject, but continuity of stimulus to the child, that is needed at this stage of development. Whatever is available and whatever meets the requirements of the instruction is to be selected, whether it fits into any definite scheme or not.

2. A wise selection from the vast amount of material is best made by the experienced teacher; but a general principle of selection should be that the material must be related to the experience of the pupils. For example, in the case of inland schools a choice between the use of a seaweed and of a tree growing in the immediate vicinity should not be hard to make.

3. The purpose in using this material should be to keep functional the tentacles of inquiry which are a possession of the

normal child. This proposition is in view of the fact that the conventional education has largely resulted in rendering these tentacles functionless, and in later years the pupil comes to science study, not merely with a loss of power, but with a loss of desire for scientific work. It is a notorious fact that the college students who are attracted by work in science represent a small percentage of those who are receiving education, and yet almost every child has been born with scientific inclinations. The great amount of work that must be done in elementary education probably precludes the cultivation of the scientific impulse during elementary training; but the thing I have in mind is at least to keep this impulse alive, so that it may be ready to lay hold of scientific material when the opportunity comes.

4. In the use of this material two things should be kept in mind: (*a*) there should be no dead work, that is, work which when done has no significance; (*b*) emphasis should be laid constantly upon function rather than upon structure. For example, in studying leaves the prominent idea is to discover, not the multitudinous forms and vein-systems of leaves, but what leaves are doing for a plant. The conception must be developed that plants are alive and at work, rather than dead things which have parts that must be named. It is easy to assign numerous topics that treat of plants from the standpoint of function, but it is the interest of the pupils that must determine the topics that are most serviceable. The exercises must hold the interested attention of the pupil, or the very purpose of the work will be defeated. I have seen a vast amount of what has been styled dead work in connection with the use of plants in elementary training. For example, the endless treating of leaves of different forms and the working out of venation of different types represent work that has no special significance when it is done. Many of the exercises seem to be devised by the teacher to employ the time assigned to carry out a requirement without any special knowledge of its significance. The statement that the interest of the pupil must be used as a test of the success of the work should be taken with due allowance.

There are some pupils who may never be interested in work of this sort, but the teacher recognizes whether general interest has been secured. There is often danger of pressing a particular problem too far, and interest is evaporated by monotonous repetition. It is the first contact that interests the young, and a judicious passing from one subject to another will keep interest from passing into disgust.

5. In my judgment the instruction in every case should be oral, and there are two prominent reasons for this proposition. In the first place, it is one of the few opportunities which come in school experience to break the bondage of the book. There is an overwhelming chance that pupils will confuse subjects with books and have no conception that the subject is something quite apart from the book that may treat of it. Besides, the fallibility of books cannot be too early emphasized. Over and over again has it been my experience that pupils who have come to the university from schools regard the statements of a book as ultimate authority rather than the testimony of their own senses. There is no better subject for teaching the real place of a book than nature-study. A second reason why instruction should be oral is that only in this way can there be the most perfect adaptation of instruction and material to pupils. Unless a book is written for a definite locality, it can never be a real guide to the best use of plant material in elementary instruction. When a teacher uses a book, the tendency is almost inevitable to follow it in its details as well as in its general suggestions. This makes the material and the order of its presentation perplexing.

6. It cannot be too strongly urged upon teachers that many of the books written to help in nature-study contain what are called "fairy-tales" by scientific men. These fairy-tales take the form either of fanciful personifications or of flights of fancy that are always wild and misleading. For example, an excellent recent book contains the following statement; "If the sky is overcast, the tree is drowsy; if rain sets in, it goes right off to sleep." To a child the meaning is entirely clear, but at the same time is entirely false. Such touches are intended to attract and

hold attention, but when the result is a misconception the attempt cannot be too strongly condemned. The claim is made that the facts of science are interesting enough to hold attention even when studied sanely. One of the peculiar advantages of the study, as contrasted with most of the other subjects handled, is that it is one subject that may be used to keep one's feet on the ground. If the plain facts of science are to be the occasion for flights of fancy, there is nothing left to enable the pupil later to distinguish between what is sane and what is wild. I fancy a large amount of what we call the gullibility of men and women who have passed through the schools arises from the fact that they have never been compelled to distinguish absolutely between fact and fancy. Nature-study in elementary instruction is exactly adapted to do this service, and hence should not be compelled to aid in the further development of an unanchored imagination.

7. It would seem wise, in order to prevent a somewhat chaotic and repetitious presentation of material, to arrange for five or six prominent problems each year, the problems differing each year, increasing in difficulty of interpretation, and together building up a real body of fundamental knowledge. In addition to these prominent problems, minor observations indefinite in number and character should be sifted in. Each problem should be of a character to involve at least four things: (*a*) individual observation or experiment; (*b*) written or sketched description; (*c*) independent conclusions; (*d*) oral instruction, with perhaps assigned readings. The individual work is necessary, not only to secure the definite contact of the subject with the mind of each pupil, but also to develop personal responsibility. It is well also to develop unprejudiced observation by giving no special information as to what will be seen. The majority of pupils are so docile that they see what they are told to see, and there is no independent observation. I have seen many cases in which younger pupils are better observers than the older ones, and I know no other reason than that the latter have been trained to become more and more dependent.

One of the most fundamentally important things is to bring together the individual results and compare them. Probably the most common error to be observed among intelligent people is generalization from a single observation. If the whole work of a class be brought together and compared, differences will be developed. These differences in observation must be settled by repeating the observation or experiment. There will thus be developed the knowledge of what is common to all the results and therefore essential. And there will also be developed a certain amount of variation. In this way a habit of caution is developed, and some idea as to what adequate proof involves. It should also be remarked that only very definite work should be assigned to young pupils; work that has already been traversed by the teacher, and whose results are assured. It is not only confusing and discouraging, but it is even disastrous, to work at random. Every observation or experiment should involve a very definite result plainly in sight.

The proper results of such training may be stated as follows: (1) a sustained interest in natural objects and phenomena of nature; (2) an independence in observation and conclusion; (3) some conception as to what an exact statement is; (4) some conception as to what constitutes proof. In short, the result should be an independent, rational individual, the kind that society needs more than anything else.

It may be well to give a concrete illustration of the kind of material that would seem to meet the conditions described. Perhaps no plant form thrusts itself more conspicuously upon the attention of pupils than trees, and acquaintance with the prominent trees of a neighborhood would seem to be one of the duties that the teacher owes to pupils in work of this kind. The first thing to be done is to select some typical forms, not taking up trees as they happen to come, but selecting here and there those known to be really representative of the different kinds. Perhaps one of the first things to do is to sketch the general plan of the tree before it is in foliage, a plan that cannot be obtained so easily when obscured by leaves. Simply to ask that a sketch be made would not be sufficient, for some pupils will go into that endless detail that only wastes time, and others are likely to go to the other extreme. The general plan must include certain definite things, such as the relative extent of the main axis, the location and direction of the main limbs, no attention being paid to the indefinitely multiplied spray. It ought not to be a conventional tree, simply a straight axis with branches, but as nearly an exact pattern of the tree-plan as can be put down upon paper. It will be a matter of surprise to most pupils to draw a conventional tree and then compare it later with the actual tree when completed. It is good to accompany this study of trees without foliage by some practice in recognizing common trees from general habit. Unless a tree has been warped or distorted, it is surprising how quickly pupils recognize the general pattern.

In this same connection study might be made of the bark, noting its thickness, the way in which its surface breaks up, and the method of shedding. The recognition of trees by the bark is also a useful exercise.

Then comes the study of the tree putting out its foliage, and the following questions are at once suggested: Which trees show leaves first? Which get into full foliage first? Which is the slowest in getting into foliage? How long after the leaves first appear is the tree in full leaf? All of these questions involve the element of time in connection with the operations of nature, an observation which very few people make. I presume it would be exceedingly difficult even for adults who have lived among trees all their lives to answer these questions. After the trees are in full foliage a study of the leaves of different types of trees may be made, so that trees can be recognized by their leaves as they have been already by their habit and their bark.

This work will result in a mass of observations, which later should be put together and the common trees of the neighborhood described as to their habit, their bark, their leaves, and whatever other characters have been developed in the course of the study. Too many trees should not be introduced early. One form should define itself clearly before another is added.

This is but an illustration of a very elementary handling of the subject of trees, which could pass later on to the study of the fiber of wood, the length of a year's growth, the rings of growth, etc.

A random list of topics that are important and at the same time within easy reach of observation by very young pupils is as follows: autumn coloration, the fall of leaves, the ascent of sap, underground habits, soils, shedding rain, transportation of seeds in dirt, the effects of drought, the relation of light to the green color and the growth of parts, the positions of leaves in reference to light.

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